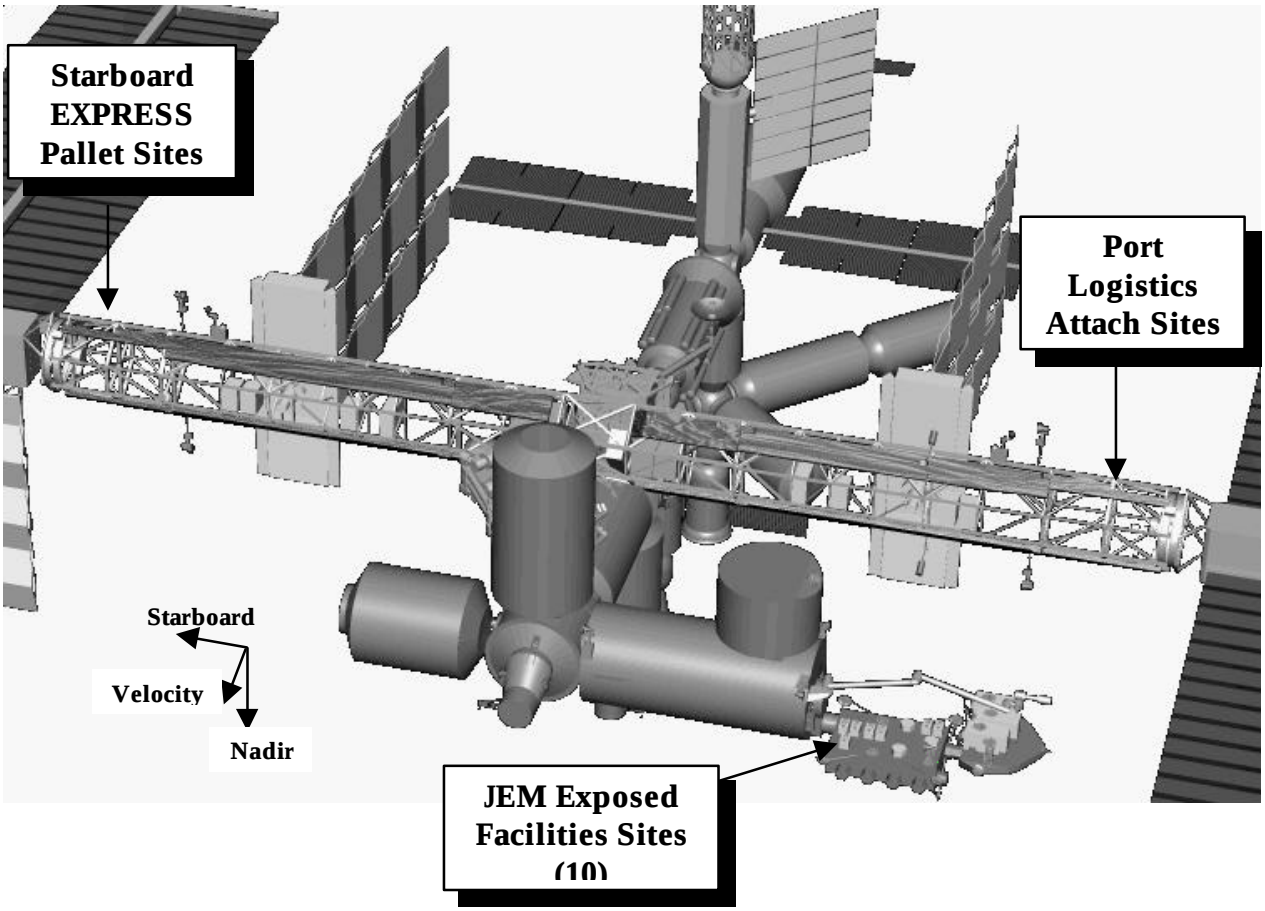
SMALL-CLASS EXPLORER (SMEX) ANNOUNCEMENT OF OPPORTUNITY
MISSION OF OPPORTUNITY INTERNATIONAL SPACE STATION (ISS) OPPORTUNITIES

The International Space Station (ISS) will provide opportunities for attached payloads at several external locations. These locations consist of the U.S. Truss via the Expedite the Processing of Experiments to Space Station (EXPRESS) Pallet, the Japanese Experiment Module Exposed Facility (JEM-EF), and Columbus Exposed Payload Facility (EPF). Each site offers unique capabilities and environments. Non-standard sites, which may not provide power or data through the ISS, may also be considered on a case-by-case basis. The ISS payload opportunity offered under this Explorer Missions of Opportunity AO solicitation is for the EXPRESS Pallet only. One zenith pointing pallet is planned initially and the current OSS allocation for two EXPRESS Pallet payloads are on this pallet.



Section 1 – ISS Environment

The ISS is currently in the process of being assembled on-orbit. While assembly complete is anticipated for late in 2004, attached payloads will be flown as the attach sites become available. The U.S. Truss sites are scheduled to be manifested in 2003, followed by the JEM-EF in 2003, and the CEF in 2004. At this time, there is no opportunity for attached payloads to return on the Shuttle until after assembly complete. The minimum lifetime of the first payloads is therefore two years.

Orbit

The ISS orbit will have an inclination of 51.6 degrees with an altitude that varies between 350 and 470 Km due to the solar cycle. The ISS orientation is continuously nadir pointed to earth. The orbit precession rate is 2 months. The ISS will pass regularly through the South Atlantic Anomaly.

Attitude

The ISS will use Global Positioning System (GPS) to determine the ISS state vector (position and velocity), attitude and altitude rates, and a time reference. GPS antennas will be located at the S0 truss segment. The system will provide a total position error of <3000 feet RSS , and an attitude error of <0.46° per axis at the GPS antenna site. This position knowledge will degrade with distance to ~1 – 2 degrees at the S3 truss attach sites. The Station will estimate the on-orbit inertial rates at the GPS origin to within 0.01° per second per axis, at a 0.5 Hz bandwidth.

The vehicle stability will be 2.5 degrees/axis/orbit. Telescopes may need an active pointing system and star tracker to accurately point at chosen targets. Pointers will not be provided by the ISS program and are the sole responsibility of the Payload Developer. Pointers are being developed by ESA for specific EXPRESS Pallet adapter payloads.

ISS Induced Environment

The requirements for the overall ISS induced environment specify the following values for molecular column density and permanent molecular deposition:

Parameter Modeled	ISS Requirements: Quiescent	ISS Requirements: Non-quiescent
Molecular Column Density	1×10^{14} molecules/cm^2	Unlimited density is allowed, but frequency is limited
Permanent Molecular Deposition	1×10^{-14} g/cm^2 s (-30 Å/yr)	1×10^{-6} g/cm^2 s (-100 Å/yr)

The ISS Program and the appropriate Research Program Offices are developing molecular deposition requirements for individual payloads. Payloads that are extremely

contamination sensitive should consider making their own deposition measurements in addition to providing protection for contamination sensitive surfaces. The contamination environment of the EXPRESS Pallet location will necessarily be determined by the Pallet analytical integration once all Pallet payloads have been selected.

There are three primary sources of induced contamination: deposition due to material outgassing, CO2 dumps, and waste gas vents from pressurized payload racks or other attached payloads. Outgassing deposition at the attached payload sites is due primarily to neighboring attached payloads. Waste gas vents are short in duration and should be scheduled. CO2 vents cannot be scheduled, but they do not exceed ISS induced environment requirements.

Safety

System safety from both a Space Shuttle and ISS standpoint will require significant consideration. The safety process is described in Section 4 of the Safety, Reliability, and Quality Assurance document located in the Explorer Program Library.

Launch Vehicle

ISS EXPRESS Pallet payloads will be launched on the Space Shuttle. Carriers for the EXPRESS Pallet payloads will be provided by the ISS Program.

Section 2 - EXPRESS Pallet Description

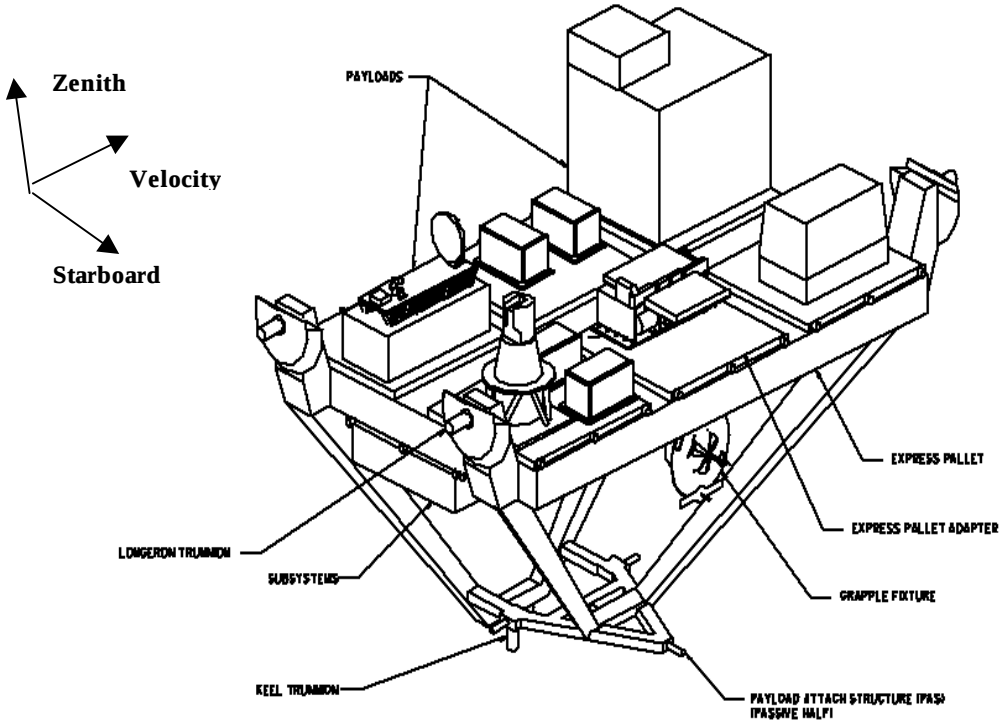
The EXPRESS Pallet provides the capability for six payloads to reside on a full truss attach site. Each payload sits on an adapter plate which attaches and detaches from the EXPRESS Pallet. The EXPRESS Pallet is managed by MSFC, and the hardware is being provided by Brazil.

Capability Per Payload

The payload mass limit is 227 Kg and must fit within an envelope of 1.1m (l) x 0.86m (w) x 1.2m (h). Up to 500W of power is available at 113 Vdc and 28 Vdc. Power usage will be limited by the thermal dissipation capability, which is site dependent. No thermal control is provided by the Pallet, and dissipation of heat into the pallet structure is limited to 50W. Data and command are available via a MIL-STD-1553 bus at ~1Mbps and ethernet access to the high rate data link at ~6Mbps.

The six payloads on a zenith Pallet sit on the zenith face of the Pallet. The Pallet itself sits on the wake side of the U.S. Truss with its longest dimension perpendicular to the Truss. All six payloads have a zenith field-of-view. The two payloads closest to the Truss will also have a ram (ISS velocity direction) field-of-view. The two payloads farthest from the truss have a wake field-of-view.

EXPRESS Pallet payloads will be provided with a Pallet adapter plate which also contains the necessary interfaces to the Station robotic arm. The first complement of Pallet payloads will be integrated with the EXPRESS Pallet at KSC and launch on the Pallet. The entire Pallet will be robotically installed on the Starboard zenith attach site. At the end of their mission life, payloads will be retrieved individually by the Station robotic arm, placed on a carrier provided by the ISS Program, and returned via the Space Shuttle.



Express Pallet Configuration

Section 3 – EXPRESS Pallet Payload Cost Assumptions

The proposer should not cost launch or landing services to the extent described below. The NASA ISS Payload Office and KSC budget process provides annual funding for KSC Launch and Landing Site payload processing. This processing is based on the Launch Manifest and approved support requirements as developed through the KSC Support requirements data set (SRDS) that is published as part the ISS payloads data set, SSP 52000-pds.

Table 3.1, Launch and Landing Site Services for NASA Sponsored Payloads, identifies existing KSC capabilities and services that are funded through the NASA budget process. This table will be included in Revision B of the SSP 52000-pds, now under review. It contains the most current information on provided services. If facilities, equipment, or service capabilities are requested that are greater than nominal levels of services available, then payload unique requirements, along with the Payload Developer (PD)

unique requirement rationale, will be documented in Section 1.3 of the Payload Interface Agreement (PIA) Addendum. The KSC assigned Launch Site Services Manager (LSSM) will assist the PD when discussing what are the nominal levels of support. Any exceptional capabilities or services will not be provided at no cost to the PD unless approved and funded through the ISS Payloads Office. Payload Developers should cost exceptional capabilities and services in their proposal cost estimate.

Other services available to payloads through the ISS Program include ground data processing and operations support services. These services are provided by the MSFC Payload Operations and Integration Center (POIC) and include telemetry and command support. The telemetry services include acquisition, storage, monitoring, processing, and distribution capabilities. The command services include generation, uplink, and response capabilities. Ground data processing and operations support functions can also be performed remotely from the payload developer's home base using the Telescience Resources Kit (TreK).

The TreK is a low cost Personal Computer (PC) based telemetry and command system. TReK consists of a PC, configured with Commercial Off-the-Shelf (COTS) software, shareware, freeware, and POIC-provided interface software applications that interface with the POIC command and telemetry interfaces. It provides telemetry and command database management services and access to other ISS software systems, such as the Payload Data Library (PDL) and the Payload Management System (PIMS). PDs are responsible for the TreK platform acquisition, system configuration, system management, and security. Using TreK, PDs will be able to command their experiments and receive, process, and display experiment telemetry. More detailed information on TreK may be found on the TreK website at http://mole.msfc.nasa.gov/trek/.

EXPRESS Pallet adapter hardware will be provided to EXPRESS Pallet payloads. The integration of the payload to the Pallet is provided without charge, but must have personnel support by the payload developer. Payload mockups for astronaut crew training are not anticipated to be required unless the payload exceeds the standard volume for an EXPRESS Pallet payload. Interfaces to the EXPRESS Pallet are the joint responsibility of the payload developer and the EXPRESS Pallet project. Interfaces between the Pallet and the ISS and between the Pallet and the Shuttle, including the associated documentation, are the responsibility of the EXPRESS Pallet project.

In addition to the standard mission management services provided by the Explorer Program, mission integration services will be provided by the OSS Research Program Office. This includes managing all interfaces between the PD and the ISS and Shuttle Programs. Assistance will be provided with technical interfaces, reviews, documentation, safety, manifesting, operations, and coordination with ISS and Shuttle programmatic interfaces including control boards, working groups, planning teams, and execution teams.

Table 3.1 LAUNCH and Landing Site Services for NASA Sponsored Payloads

KSC Support Services		
Operations Support Services		Institutional Support Services
1. Pre-arrival planning/analysis support 2. Ground Safety Review process 3. Transportation support - Arrival-Aircraft/Barge/Truck - Facility to facility - Intra-facility 4. Facility Utilization - Space Station Processing Facility (SSPF) Offline areas - User Rooms - Life Science Processing Facility - SSPF Crane support 5. KSC Ground Support Equipment 6. Communications including Operational Intercommunication System (OIS) 7. Warehouse storage (limited) 8. Packing/crating shipping support 9. Control work area access badging 10. Training for facility access and certifications 11. Clean room garments 12. Sampling and analysis (select) 13. Tools and special test equipment 14. Lifting equipment proof load 15. Equipment calibration 16. Technical shops 17. Office space 18. Photographic services 19. Hazardous waste disposal 20. Consumables (GN2, He, shop air, ISS flight water) 21. Computer Ethernet connections 22. Chemicals (select) 23. KSC Technical Document Center		1. Emergency medical 2. Copy center and self service document reproduction 3. Self service document facsimile transmission 4. Federal Telephone System 5. KSC reference library* 6. Bus service between buildings* 7. Cafeteria (first shift only)* 8. On-Center commercial travel office* 9. KSC wide security access 10. On-Center security escort for equipment moves 11. Janitorial services* 12. Mail service* 13. KSC area access badging 14. U.S. Customs planning/assistance support 15. KSC Telephone Operator Support* * Monday thru Friday, 8:00am – 4:30pm

Section 4 – OSS Research Program Office for ISS Utilization

The OSS Research Program Office (RPO) for ISS utilization is the primary point of contact for all proposers interested in flying payloads on the ISS. Questions regarding ISS utilization, accommodations, and interfaces should be addressed to the Research Program Manager, Betsy Park, GSFC, Greenbelt, MD 20771, (301)286-7062, fax 286-0232, bpark@pop400.gsfc.nasa.gov.

The RPO, in conjunction with the OSS, is responsible for working ISS allocations, manifesting, ISS and STS interfaces for payloads, and issues regarding any of the above. Mission management of ISS payloads will be handled in the same manner as all Explorer missions.

Section 5 – References

More detailed information on ISS accommodations and requirements may be found in the ISS Utilization Guide at http://spaceflight.nasa.gov/station/science. This document will become available fall 1999.

Additional Reference:

1. EXPRESS Pallet Interface Definition Document
(Availableupon request)